

Reply to “Comment on Anderson Transition in Disordered Graphene”

MOHSEN AMINI¹, S. A. JAFARI^{1,2}, FARHAD SHAHBAZI¹

¹ *Department of Physics, Isfahan University of Technology, Isfahan 84156-83111, Iran*

² *The Abdus Salam ICTP, 34100 Trieste, Italy*

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Abstract. -

In a recent comment by Schleede and coworkers [1], they have correctly pointed out presence of small negative spectral weights of the order 10^{-4} in RKPM expansion of the Dirac delta function. However, we found that these negative values are not responsible for the vanishing of the typical density of states (DOS) near the charge neutrality point.

To clarify this point, in Fig. 1 we have plotted a Dirac delta function with Jackson attenuation factors (Solid line), and with RKPM (dashed line). The Gibbs oscillation seen in the dotted line are washed out both with Jackson as well as RKPM damping methods. As can be seen in the figure, the height of Dirac delta peak is underestimated by RKPM relative to the one obtained with Jackson g -factor. Such underestimation of the LDOSs, along with small σ broadening of kernel might be a possible reason for vanishing of typical DOS in regions with larger level spacing. Since largest level spacing in the tight-binding spectrum of graphene appears around the Dirac point, one expects to obtain vanishingly small LDOSs giving rise to the mobility edge reported in our letter [2]. We repeated our calculations with larger kernel width, and we obtain results similar to those obtained in Fig. 2 of Ref. [1]. Therefore we agree that the existence of mobility edge can be due to subtle details of the kernel used in the expansion.

However, we do not agree with the main conclusion of the comment that smallest amount of uncorrelated on-site disorder in 2D honeycomb lattice is capable of localizing the entire spectrum. To discuss this claim, we present the following three arguments: (i) Let us repeat the same scaling analysis presented in right panel of Fig. 3 in Ref. [1]. In Fig. 2 we show the scaling analysis at fixed energies for $W/t = 12$ for a tight-binding model on a cubic lattice for which the critical value $W_c/t \sim 16.5$. In agreement with previous works of the above authors [3], for this value of disorder, one expects all states to

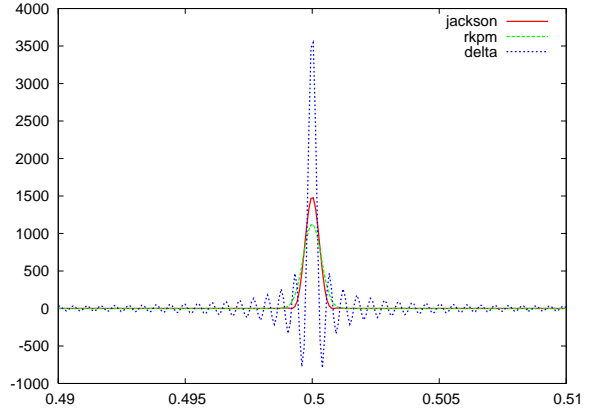


Fig. 1: Comparison of Dirac delta expansion corresponding to the same expansion order, $N = 10^4$.

remain extended. As can be seen in Fig. 2, although the ratio $R(E) = \rho_{\text{typ}}(E)/\rho_{\text{av}}(E)$ decreases by increasing system size, it finally saturates for larger sizes. In absence of a rigorous theory for the size dependence of $R(E)$, the scaling result presented in right panel of Fig. 3 of the comment does not conclusively imply the localization of all states for the small value of disorder considered.

(ii) The log-normal fitting to the distribution of LDOSs presented in left panel of Fig. 3 of the comment, shows that peak location of the distribution stays more or less fixed at $\ln(\rho/\rho_{\text{av}}) \approx 0$ by increasing the lattice size. This means that majority of LDOSs are equal to the mean value of DOS; a characteristic of extended states. On the other hand, the width of the distribution seems to saturate in the limit of large lattice sizes, which indicates states with energy $0.25t$ at $W/t = 0.3$ are not

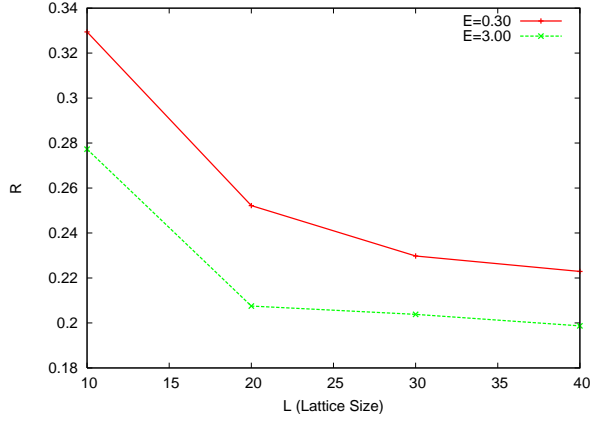


Fig. 2: Scaling behavior of R for different values of energy with $W/t = 12$ in cubic lattice.

going to get localized.

(iii) A large body of experimental data support the existence of a minimal conductivity in various graphene samples. This is in sharp contradiction to the main conclusion of the comment. Most spectacular experimental realization of short range on-site disorder in graphene was achieved by ARPES analysis of the Hydrogen dozed graphene samples [4]. The Anderson transition was observed in this experiment beyond a certain level of dozing. This experiment shows that, above a critical disorder strength, state around the Fermi level seen in the ARPES are localized as indicated by d.c. conductivity measurements [4].

As a closing remark, the question of, whether a mobility edge in graphene exists or not [5, 6], remains open and requires further theoretical and experimental investigations.

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